

## Introduction:

The CT-125 is a laboratory quality frequency counter that is capable of use in the lab as well as in the field. Utmost care has been taken in all the design to insure that sensitivity and reliability were not compromised. The CT-125 has been specially built for the critical user, as demonstrated by; nine digit display, three gate times, and a count hold feature.

The CT-125 is also ideal for portable usage. Leading zero blanking allows 2-4 hours of continuous operation using the internal battery supply.

## Specifications:

### Frequency Range:

20 hz to 10 mhz (10 mhz range)  
100 hz to 60 mhz (60 mhz range)  
10 mhz to 1.0 ghz, 1.3 ghz typical (1 ghz range)

### Sensitivity:

less than 25 mv @ 50 mhz (direct input)  
less than 15 mv @ 500 Mhz (typical 10 mv)  
less than 60 mv @ 800 mhz (typical 70 mv)  
less than 100 mv @ 1 ghz

### Resolution:

0.1 hz (10 mhz range)  
1.0 hz (60 mhz range)  
10.0 hz (1 ghz range)

### Input Impedance:

1 meg ohm, 33 pfd (10 and 60 mhz)  
50 ohms (1 ghz)

### Input Protection:

10 and 60 mhz range; 150 vac to 10 mhz  
50 vac to 60 mhz.  
1 ghz range; 5 vac

### Time Base:

10.0000 mhz 10 and 60 mhz range  
3.90625 mhz 1 ghz range  
temperature compensated TCXO  
1.0 ppm 20degree to 40 degree C

### Display:

9 digit, 0.4" height  
automatic decimal placement

### Power:

8-15 V AC/DC at 250 MA MAX  
4 'AA' size NICAD batteries

### Size, Weight:

5"x5"x1½", 1 pound with batteries

Operation: Operation of the CT-125 is very simple, simply connect your input signal to the proper input jack (10, 60 mhz or 1 ghz) and select the range and gate time. All switches are mounted on the front panel in easy view of the user. A description of the front panel controls are as follows:

POWER:

OFF turns the counter off

ON turns the counter on

HOLD stops the clock signals to the counter circuits and holds the count that is displayed.

GATE:

0.1 sec position selects a one tenth second gate period. The gate period is the time interval over which input pulses are counted. The faster gate period allows a faster updated count at the expense of less resolution.

1.0 sec position selects a one second gate period. This position is used when better resolution is required.

10 sec position selects a ten second gate period. This position is used only when extreme accuracy is required and a long term, stable signal is available. Note that on the 1 ghz range, actual gate times are 2.5 times longer.

RANGE:

10 mhz position is used when input signals are connected to the 10,60 mhz input jack. The counter will then count up to 10 mhz with 0.1 hz resolution. (10 sec gate)

60 mhz position is used when the input signals are connected to the 10, 60 mhz input jack. The counter will then count up to 60 mhz with 1,0 hz resolution. (10 sec gate)

1 ghz position is used when the input signals are connected to the 1 ghz input jack. The counter will then count up to 1 ghz with 10 hz resolution. (10 sec gate) Gate times on the 1 ghz range are 2.5 times longer than indicated.

GATE LIGHT:

Indicates when the counter is actually measuring input signals. The gate light gives a visual indication of gate time and counter operation. It is extremely useful when using the longer gate times.

## Theory of Operations:

General: Regardless of the type or complexity of a frequency counter, all instruments measure frequency by counting input pulses with respect to a known frequency or time base. The time base generates a precisely controlled time interval, selectable to be one second or one-tenth of a second. During this period, the counter is enabled and input pulses counted. When the time period is up, the number of pulses counted is then displayed. A long gate period allows more pulses to be counted, and the more pulses counted the better the resolution. The limiting factors governing resolution are the number of digits in the display and the tolerable gate period. Usually 1.0 hz is the best resolution practical for an easy to read count. Of course it is not always necessary to read frequency to a hertz or wait for a one second count. By selecting a shorter gate period, you can reduce the display update time and get a faster reading display, but at the expense of poorer resolution.

Detailed Theory: The UHF and VHF inputs have been kept separate to increase the input sensitivity by eliminating switching losses. The UHF signals are feed thru J1 into U1, the first divider stage, then to Q1, a wave shaping transistor stage. From there the signal is then sent to U2, divide by ten IC.

The VHF input is much different because it must be of a very high impedance. The signal is feed thru J2, past CR3 and CR4 input protection diodes to the gate of Q2, FET. The combination of the FET and Q3 bootstrap bipolar transistor follower provides the high impedance required. The signal is then sent to the three stage line amp U4. This IC is an ECL device that limits and shapes the signal. Transistor Q4 then converts the ECL level to a TTL level signal that the rest of the counter requires. The input to U2 divider is selected by the range switch. Its input can come from the UHF section (U1) or the VHF section (Q4). If the 10 mhz mode has been selected U2 is bypassed completely and the signal is sent directly to U3, the counter IC.

The timebase for U3 is supplied by Y1 and Y2, and their associated components. The counter IC will use which ever timebase that has been selected. The counter IC generates all its own housekeeping functions such as multiplex, strobe, gate and reset signals. a logic circuit inside the counter IC senses the scanned readout signals (D0 thru D7) and also the input to pin 14, the gate select input. By comparing these inputs, the counter IC generates the selected gate time. The decimal point is displayed the same way. A logic circuit inside the IC looks at the scanned outputs D0 thru D7 and compares this with the signals selected by S2.

The power supply uses a simple bridge rectifier circuit that will accept an AC or DC input. Regulator VRL provides a stable 5V power source while R28 and CR12 provide the charging current for the nicads (if used). Capacitors C15 and C16 provided added filtering.

## HOW TO USE YOUR COUNTER

Using your counter is usually just as easy as connecting the signal to the input jack and counting. However, in some instances, such as noisy signals or low frequencies, care must be taken in applying the signal to the counter. The counter not only has a high input impedance but also high sensitivity. Noise accompanying the desired signal may fall within the counter's sensitivity and frequency limits, and be counted. This signal plus noise input is amplified and counted within the instrument, and produces a jittery, unstable display. The solution to this problem is to attenuate the signal plus noise to the level where the noise is below the counter threshold. A scope X10 probe is ideal for this purpose, an easily constructed probe of this type is described later on.

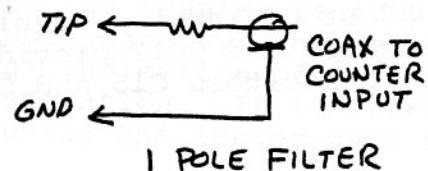
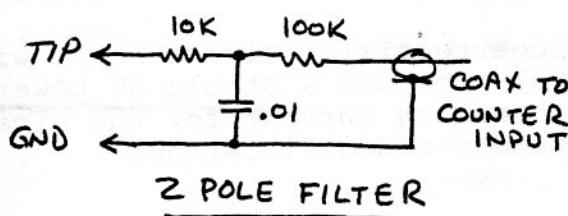
Another problem area is ringing at the counter input. Consider the coax cable from the signal to be measured to the input jack, it's a transmission line, just like your antenna coax on a transmitter. Being so, a standing wave phenomenon can occur if impedances are mismatched. If a signal from a low impedance source is presented to the coax cable, and the cable is connected to the high impedance counter input, the signal will be mismatched. This mismatch will cause the signal to reflect from the input and return, causing again, an unstable display.

Yet another consideration is that of ground loops. If your counter probe is grounded to the circuit to be measured, and the counter case also grounded (whether physically or induced) a ground current along the cable can exist. This ground current will produce a voltage which, if it is AC will be counted.

Fortunately, most of these problems are easily solved by thoughtful selection of coupling the input signal. This involves determining just what sort of signal you are attempting to measure.

For Low Frequency (less than 20 khz) Measurement: Low frequency measurements are usually upset by excessive noise riding on the input signal, ground loops or ringing. Even though you may feel the signal is very "clean", the counter can count up to VHF and noises or ringing will be counted. The use of a low pass filter will prevent any high frequency noise or ringing to be presented to the counter input. Preventing a ground loop is not quite as easy as using a different probe. Generally, providing a ground path other than the probe's ground will solve the problem. Two simple low pass probes are shown:

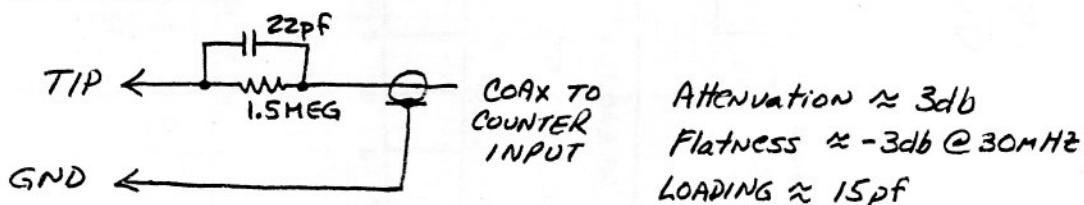
### LOW PASS PROBES:



COAX MAY BE RG-58 OR RG-174 3-8 feet in length

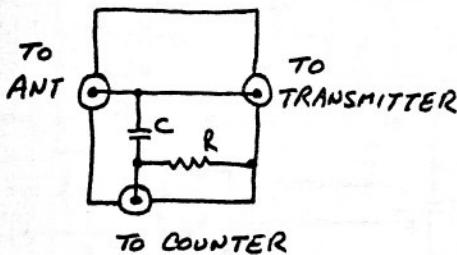
For General Usage (20 khz to 60 mhz): The majority of signal measurements are usually within this range. Ringing and noise are the chief culprits in measurement. The only way to counteract these undesirables is to damp the ringing and/or attenuate the noise (with the signal too, unfortunately). A simple X10 oscilloscope probe works well to attenuate noise as well as providing a less loading probe. If the noise is at a 10 mv level and signal at 1 volt, the X10 probe will reduce the noise to 1 mv and the signal to 100 mv, thus noise is out of the counter's sensitivity range, while the desired isn't. The X10 probe or high impedance probe will also generally damp out ringing. Another benefit of the high impedance probe is that it doesn't load the circuit being measured by the input cable's capacitance. This is especially important when measuring oscillators or amplifiers. A simple high impedance probe is shown below:

HIGH IMPEDANCE PROBE:



For Direct Transmitter Measurement: Measuring a transmitter requires coupling enough transmitter energy into the counter for a stable count and not so much as to exceed the counter's safe input. Generally, for VHF work, a small 18" whip antenna will pick up a transmitter from 5 to 10 feet away. Direct connection to the transmitter can be made via a coupling box or pick up loop. The pick up loop is simply a few turns of wire wrapped around the transmitter's antenna coax and fed to the counter. The coupling box requires breaking into the transmitter's antenna coax. Schematic is shown below:

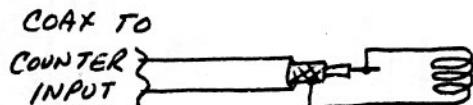
COUPLING BOX



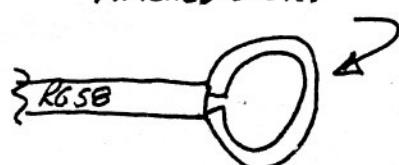
MOUNT 3 COAX CONNECTORS  
IN A SMALL METAL MINI-BOX—  
THIS INSURES SHIELDING

FOR 2-50MHz  $C = 10\text{pf}$   $R = 51\Omega$   
50-450MHz  $C = 2\text{pf}$   $R = 51\Omega$

SNIFFER LOOP

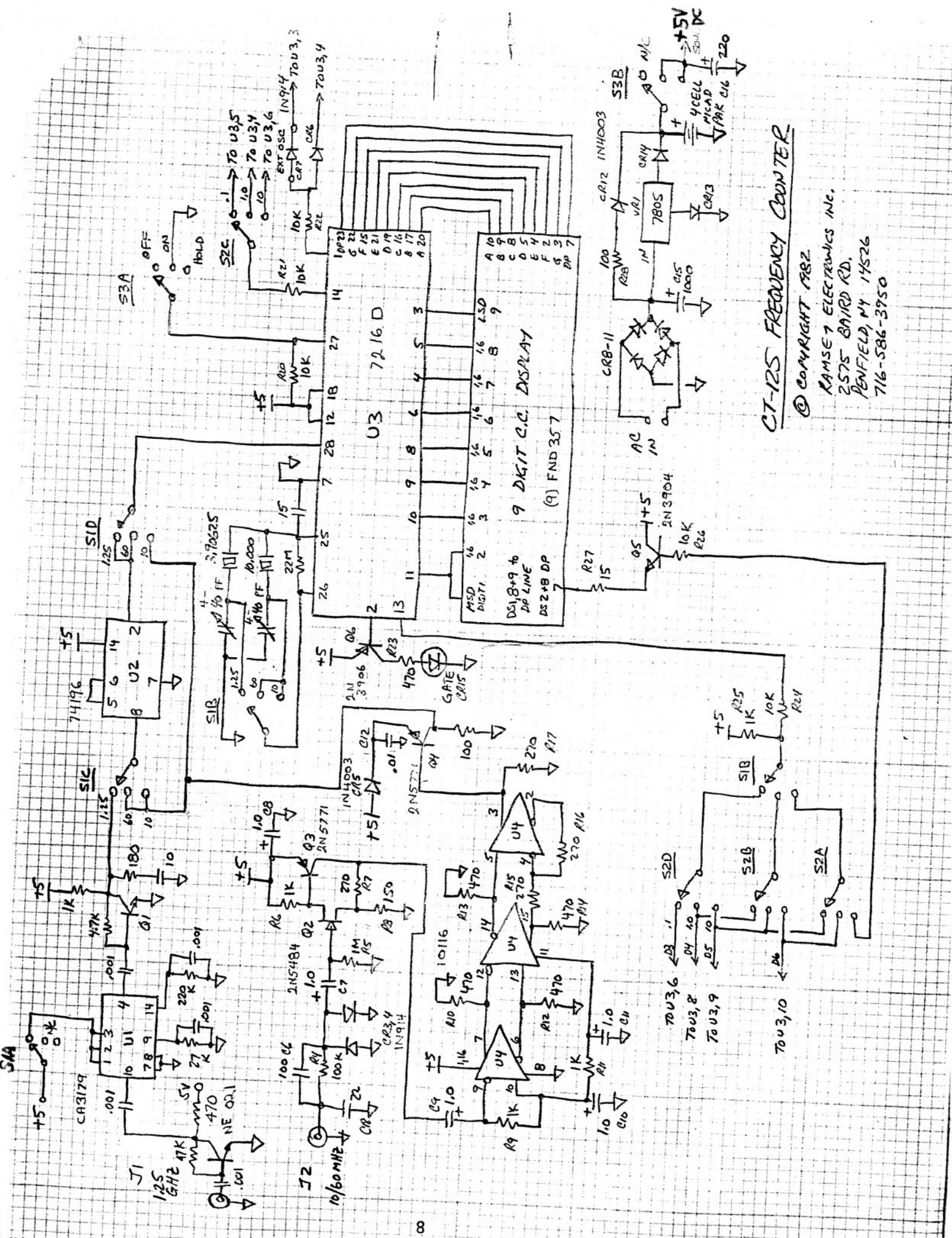


COIL IS ABOUT 3 TURNS OF  
#22 WIRE ON 1/2" DIAMETER  
ENCLOSE WIRE AND CABLE IN  
SHRINK TUBING FOR A NEAT,  
FINISHED LOOK.



## FREQUENCY COUNTER ASSESSORIES

CT-125 110 VAC power adapter, AC-1  
CT-125 Nicad battery pack and adapter  
DC Probe, direct input  
High Impedance Probe, low circuit loading  
Low Pass Probe, for audio measurement  
High Pass Probe, reduces low freq. pickup  
Collapsible whip antenna (20 inches)



## WARRANTY INFORMATION

RAMSEY ELECTRONICS WARRANTY APPLIES TO ORIGINAL PURCHASERS ONLY

### PARTS

ALL KIT PARTS ARE WARRANTED TO BE DEFECT FREE FOR A PERIOD OF NINETY (90) DAYS FROM DATE OF PURCHASE. PARTS SUSPECTED OF BEING DEFECTIVE RECEIVED AT THE FACTORY FOR INSPECTION, WILL BE REPLACED AT NO CHARGE. RETURN THE DEFECTIVE PARTS ONLY (IN SUITABLE CONDITION FOR TESTING). DO NOT RETURN ENTIRE KIT.

### KITS

TO QUALIFY FOR FACTORY REPAIR, KITS MUST:

1. NOT BE ASSEMBLED WITH ACID CORE SOLDER OR FLUX.
2. NOT BE MODIFIED IN ANY FORM.
3. BE RETURNED IN FULLY ASSEMBLED FORM NOT PARTIAL.
4. BE ACCCOMPANIED BY PAYMENT OF PROPER REPAIR FEE. REPAIR WILL BE DELAYED WAITING FOR PROPER PAYMENT RECEIPT.
5. HAVE A DESCRIPTION OF THE PROBLEM AND LEGIBLE RETURN ADDRESS. INCLUDE PROOF OF PURCHASE

DO NOT SEND SEPARATE LETTER. ENCLOSE ALL CORRESPONDENCE WITH UNIT.

### REPAIR CHARGES

| PRODUCT            | AMOUNT   |
|--------------------|--|
| FREQUENCY COUNTERS | \$25.00 (BASIC)                                      |
| POWER AMPS         | \$20.00 (BASIC)                                      |
| KITS               | \$18.00/HOUR (INCLUDE (\$18.00 INITIAL)<br>(AMOUNT)) |

### FACTORY ASSEMBLED UNITS

ALL FACTORY ASSEMBLED PRODUCTS ARE WARRANTED TO BE FREE FROM DEFECTS IN PARTS OR WORKMANSHIP FOR A PERIOD OF ONE (1) YEAR FROM DATE OF PURCHASE. THIS WARRANTY APPLIES TO UNITS THAT HAVE NOT BEEN MODIFIED, MISUSED, ABUSED OR REPAIRED BY UNAUTHORIZED PERSONNEL.

RETURN SHIPPING AND INSURANCE REMITTANCE OF \$3.00 IS REQUIRED. TIME INVOLVED FOR WARRANTY REPAIR DEPENDS UPON THE PRODUCT. IT TYPICALLY RUNS ONE TO TWO WEEKS AFTER FACTORY RECEIPT. INCLUDE PROOF OF PURCHASE.

RAMSEY ELECTRONICS, INC. RESERVES THE RIGHT TO REFUSE REPAIR ON ANY ITEM DUE PURCHASER CONSTRUCTION TECHNIQUES.

### REFUNDS

YOU ARE GIVEN TEN (10) DAYS TO EXAMINE OUR PRODUCTS. IF NOT SATISFIED YOU MAY RETURN TO FACTORY FOR REFUND. PRODUCT MUST BE RETURNED IN ORIGINAL CONDITION (UNASSEMBLED IF KIT) WITH ALL PARTS AND INSTRUCTIONS. INCLUDE PROOF OF PURCHASE

PACKAGE ALL RETURNS PROPERLY. INSURANCE IS RECOMMENDED. DO NOT CAUSE NEEDLESS DELAYS. READ ALL INFORMATION CAREFULLY.